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TECHNICAL EFFORT

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Dr. Dillaway has explained why the military has such a keen interest in flexible packaging. I will summarize the technical effort expended by Natick Laboratories up to the determination of the need for the contract effort that is the subject of this symposium.

When flexible packaging was first considered, it was felt that neither the packaging materials nor the laminating techniques available were adequate to meet the need. Therefore, initiation of the project was delayed until our review of the state of the art indicated a sufficiently high success potential.

Very early in our consideration of the new system a decision was made to use conventional steam- or water-cook retorts. Aseptic packaging was considered, but at that time very little heat-exchange equipment was available for anything other than liquids and semiliquids. Equipment and techniques were non-existent for sterilizing and subsequently handling film materials. (The Flash-18 process came along later.) Realizing that there were problems associated with packaging equipment, we chose not to add the additional problems associated with aseptic packaging. Steam- and water-cook retorts were the standard that was generally available in the plants of food processors.

TECHNICAL REQUIREMENTS

In our study of the problems, we identified eight major technical requirements that the flexible package must meet. They are as follows:

(1) It must be able to withstand exposure to 250°F in water or steam for approximately 30 minutes.
(2) Its seals and bonding agents must be adequate to withstand fluctuations in pressure in the retort at 250°F.
(3) The materials must meet or surpass U.S. Food and Drug Administration regulations.

(4) The sealed package must be resistant to bacterial penetration.
(5) The package, after retort processing, must preserve its contents at an acceptable level of quality for at least 6 months at 100°F and 2 years at 70°F.
(6) The package must fit into the pockets of the field clothing.
(7) It must be easy to open.
(8) It must withstand the hazards of shipment and handling in the military supply system without loss of integrity.

The first 2 years of the program were devoted to evaluating materials submitted by industry before a material suitable for processing at 250°F was found. The suitable material was a lamination of 3.0 mils vinyl, 0.35 mil aluminum foil, and 0.5 mil polyester with the vinyl surface in contact with the food. Later, the vinyl was replaced by a modified polyolefin or high-density polyethylene. More than 200 materials have now been evaluated for the program.

The earliest overall package design consisted of the pouch with a fiberboard backing on one side and the four seals protected by a fiberboard picture-frame arrangement on the other side. When we realized that the pouch required complete protection against mechanical damage, the present fiberboard folder package was designed. In evaluating its performance, it was found that bonding the pouch to the folder provided four times better performance than just placing the pouch in the folder.

EARLY TESTS

Having selected materials and a design that would perform in the retort and also provide mechanical strength, it was essential to determine whether the structure was resistant to penetration by bacteria. Studies were made under contract to determine the resistance to bacterial penetration of each component film as well as the complete lamination. They showed that each of the components (polyolefin, aluminum foil, and polyester) might be penetrated through pinholes inherent in the materials, but that the three films laminated together effectively overcame this weakness. No penetration of the composite structure was experienced except when deliberate mechanical damage caused a complete break through the three layers.

Further studies were conducted to determine type and amount of extractable substances that might migrate from the packaging material into the food during thermoprocessing. These tests showed that the materials were well within the safety limits established by the Food and Drug Administration.

Packages containing fruits, meats, and vegetables were stored for periods up to 1 year at 100°F and up to 2 years at 70°F. Examination of these indicated that both package and contents were acceptable over this period.

To determine the performance under simulated field conditions, packages were subjected to durability tests at Fort Lee, Virginia. The tests consisted of placing a number of packages in the pockets of troops who traversed an obstacle course as many as five times. The results of these tests indicated that the packages were satisfactory for field use.

An engineer-service test of the packages indicated a failure rate of 0.3 percent among 50,000 examined packages. Failures were primarily due to poor seals and punctures, which were production deficiencies caused by the lack of adequate equipment to form, fill, and seal the packages.

The results of this test required that concentrated effort be directed toward problems of sealing, leak detection, testing of seals, and determination of package reliability under production conditions.

Seal failures were caused primarily by food, oil, grease, and moisture being entrapped in the seal area and by wrinkles. Sealing through oil, grease, and moisture was solved at Natick Laboratories by use of a curved-jaw sealing bar and a silicone-rubber anvil system. A system to detect defects in the seals was developed. It consists of a scanning device that measures changes in infrared radiation along the seal produced by changes in the seal structure. Single pineapple fibers, a single sugar crystal, and voids in the seal, for example, are easily detected by infrared. A prototype scanner with an automatic rejection system for on-line examination of closure seals is available.

The remaining problem was to determine the reliability of the flexible package under production conditions. This symposium is devoted to our efforts to solve this problem.